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FEEDING AND GROWTH OF *COELOTES ATROPOS* (ARANEAE, AGELENIDAE) AT LOW TEMPERATURES

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ABSTRACT

Feeding by *Coelotes atropos* decreases sharply at and below 6°C compared to that at 8°C and 10°C. As temperature decreases, each individual requires less energy in terms of calories. No growth occurred below 8°C, suggesting a developmental zero between 6° and 8°C.

INTRODUCTION

Most research on feeding and growth of spiders has been conducted at temperatures between 10° and 20°C (Miyashita 1968, Hagstrum 1970, Petersen 1971, Schaefer 1977, Workman 1978). However, some species which are active under snow in southern Canada may feed and possibly even grow at temperatures close to 0°C (Aitchison 1978).

Coelotes atropos (Walckenaer) constructs silk-lined tunnels under stones, with a collar of silk at the main entrance (Bristowe 1958). Adults mate in spring and early summer, then the female deposits her egg cocoon in a tunnel in June, guarding it and later the spiderlings for the rest of her life (Bristowe 1958). This paper describes quantitative feedings and growth of *C. atropos* collected from the field and reared at constant temperatures from 2° to 10°C. The study was undertaken to ascertain the extent of feeding and growth of this spider during winter months in northern England.

AREA AND METHODS

The animals were collected from an ash-sycamore wood (*Fraxinus excelsior-Acer pseudoplanatus*), on the west side of Lake Windemere, Ferry House, Keswick, Cumbria, England.

Young spiders, instar III or IV, were collected with an aspirator from tunnels on 22 August 1977, when the mean ground temperature was 13.5°C. All spiders were transported to the laboratory at the University of Manchester in plastic bags containing damp filter paper. At the laboratory the spiders were placed in individual vials, 4 dram size, with 1 cm of damp sand at the bottom and fitted with cork stoppers. The animals were temporarily stored at 12°C in groups of 25 spiders each. The temperature was lowered by

2°C every 2 days, one group being retained at each of the test temperatures, 10°, 8°, 6°, 4°, and 2°C. The temperatures in the incubators varied ±1°C.

Adults of vestigial-winged *Drosophila melanogaster* Mg. were fed to the spiders, 2 to each of the juveniles and 4 or 5 to each of the adults every two days (about maximum consumption). The number of flies eaten was determined by the shrivelled remains; these, and any other dead flies, were removed at feeding times. The dates of molts and deaths were noted.

Growth was determined by the number of molts per individual which occurred at each temperature. Measurement of the length of the first leg was calculated on each exuvium.

RESULTS

Several incubator failures necessitated analysing only the data between days 120 and 290, providing 17 complete 10-day periods. There were 21 juveniles at 10°C, 10 at 8°C, 10 at 6°C, 20 at 4°C, and 19 at 2°C. Since there were only 2 or 3 adults at each temperature, the sample size was too small to draw any meaningful conclusions. Thus only the analysis of data on juveniles is considered.

The number of flies eaten per 10-day period was analysed using a repeated measures analysis of variance. The analysis revealed significant temperature differences ($P < 0.01$). The least significant difference (LSD) multiple range test revealed significantly more flies were eaten at 8° and 10°C than at 2°, 4°, and 6°C ($P < 0.01$), averaged over 10-day periods (Figure 1). Furthermore there were no significant differences in consumption rates between the temperatures 2°, 4°, and 6°C or between 8° and 10°C. The mean number of flies eaten averaged per individual per time period was as follows (± the pooled estimate of standard deviation): 2°C, 0.43 ± 1.38 flies; at 4°C, 0.57 ± 1.38; at 6°C, 0.96 ± 1.38; at 8°C, 6.19 ± 1.38; and at 10°C, 5.85 ± 1.38 flies.

Analysis of time periods revealed significant differences across time periods ($P < 0.01$) as well as a significant interaction of time periods and temperature ($P < 0.01$). There was no apparent trend to the shape of the response across time however.

From the mean number of flies eaten, an estimate of the number of calories consumed at each temperature may be made. Assuming that each fly averages a live weight of 1.0 mg fresh weight/fly or the equivalent of 1.07 calories (Edgar 1971a), then at 2°C in a period of 10 days, a juvenile spider consumed a mean of 0.46 ± 1.48 calories; at 4°C, a mean of 0.61 ± 1.48 calories; at 6°C, 1.03 ± 1.48 calories; at 8°C, 6.62 ± 1.48 calories; and at 10°C, 6.26 ± 1.48 calories.

The measurements of the first leg over time do not provide adequate data for separation into instars, and only the number of molts per individual at each temperature is considered. At 10°C, 11 juveniles molted once, 10 twice and one specimen three and four times, while at 8°C, 14 juveniles molted once, 7 twice and one individual three times. This contrasts sharply with the molts at the lower temperatures; in the test time between 120 and 290 days there were no molts.

DISCUSSION

The effects of temperature have a direct result on the food consumption and basal metabolic rate in poikilotherms. A high food consumption was demonstrated very clearly by the juveniles of *C. atropos* held at 10° and 8°C, while those at 6°C and below ate

significantly less. Subadults of *Pardosa lugubris* Walckenaer held for 140 ± 8 days at 4°C, the length of the inactive period in the field in Scotland, fed very little. It was concluded that winter food consumption was negligible (Edgar 1971b). At 4°C the food intake by juvenile *C. atropos* was 0.57 ± 1.38 flies eaten/10 days.

Lack of growth during winter is associated with most invertebrates (Edgar 1971b, Workman 1978). The last molt of *Lycosa T-insignita* Boes. et Str. was inhibited by low winter temperatures and possibly by hunger until spring (Miyashita 1968). The third overwintering instar of *Tarentula kochi* Keyserling is active down to 6°C and has a developmental zero of 10°C (Hagstrum 1970). In the time period of 120 to 290 days, only those juveniles of *C. atropos* held at 8° and 10°C molted, while those at lower temperatures had their molts inhibited.

The significant differences between the feeding of spiders held at 8°C and above and that of those held at 6°C and below suggest that there is a major physiological change in the metabolism of *Coelotes* at around 7°C. The significantly different food consumption and lack of growth at lower temperatures also support this hypothesis. Hence it may be surmised that the developmental zero occurs between 8° and 6°C for this species, with locomotory activity feasible down to 2°C. Another interesting point is that the maximum survival of adults occurred at 6°C.

There can be considerable differences in the developmental zeros of various species. For example, Schaefer (1977) found that *Allomengea scopigera* (Grube), which matures in the autumn, grows in a broad temperature range and has a developmental zero of -4°C, while *Thanatus striatus* C. L. Koch (stenochronous) is dependent upon high temperatures for development and will not develop below about 12°C. In this case *C. atropos* appears to have an intermediate developmental zero; it is obviously not adapted to low temperatures as is *A. scopigera*.

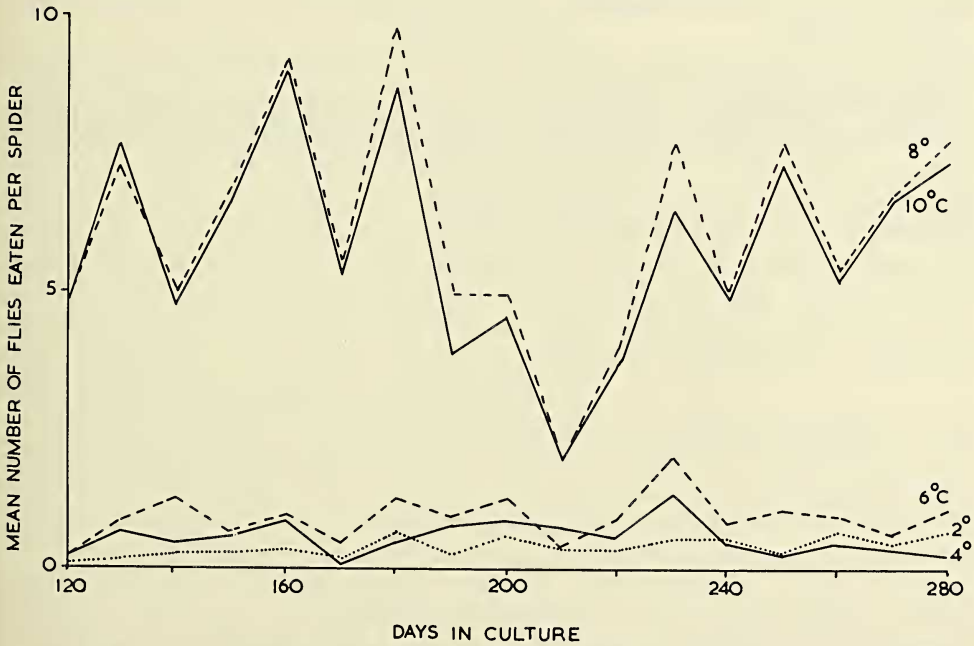

Fig. 1.–The mean number of flies eaten per spider per ten days by *Coelotes atropos* juvenile at different temperatures.

During winter months in the field spiders would be at an advantage, having a reduced food consumption when the availability of prey is at its lowest point, and yet still be reasonably mobile. Their mobility and occasional feeding at 2°C would help them survive some of the lower temperatures to which they are exposed, although under stones on the soil surface the microclimate would be several degrees warmer than the ambient air temperature.

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